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AN ASSESSMENT OF WATER QUALITY IN THE CLARK FORK RIVER AND ITS TRIBUTARIES BASED ON THE STRUCTURE AND COMPOSITION OF SUMMER ALGAE ASSOCIATIONS IN THE STREAM-BOTTOM PERIPHYTON COMMUNITY

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An assessment of water quality in the Cl
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SUMMARY

Benthic algae samples were collected from natural substrates at 25 stations on the Clark Fork River and selected tributaries in August 1987 and again in August 1988. Samples were analyzed for relative abundance of non-diatom genera, relative abundance of diatom species, number of non-diatom genera, number of diatom species, diatom species diversity, and relative abundance of diatoms in different pollution-tolerance groups.

Algae data indicated severe water pollution and use impairment in Silver Bow Creek. The principal cause of pollution was metals above the Butte WWTP and a combination of metals and excess nutrients below the Butte WWTP.

Moderate pollution and use impairment were indicated from the Warm Springs Pond #2 discharge downstream to Bonita, including the Mill-Willow Bypass and Warm Springs Creek. The main cause of impairment at these sites is nutrient enrichment, although heavy metals also have some effect.

Free-living and endophytic nitrogen-fixing blue-green algae are most abundant from Gold Creek to Turah. Here they are favored by a combination of relatively high phosphorus concentrations and seasonally low N:P ratios. This is the same reach of river where _Cladophora_ has attained its largest standing crops.

INTRODUCTION

This report describes the results of benthic algae surveys conducted in August 1987 and August 1988 as part of the Clark Fork River Basin Monitoring Project of the Department of Health and Environmental Sciences. Results of water quality monitoring activities carried out under this project from July 1, 1987 to June 30, 1989 are described in a report by Gary Ingman and Mark Kerr (December 1989). Results of benthic macroinvertebrate surveys conducted at the same time as these algae surveys are described in reports by Dan McGuire (July 1989, November 1989). Results of a similar benthic algae survey conducted in August 1986 are appended to this report (Appendix A).

Periphyton (a.k.a., aufwuchs, biofilm, slime layer) is the community of small plants, animals, bacteria, and fungi that live attached to or in close approximation with stream-bottom substrates. Simple microscopic plants called algae are the primary producers of the periphyton community. Algae have several advantages as biomonitors of water quality:

1. They are normally present in very large numbers, making it easy and inexpensive to collect a statistically valid sample while minimizing disturbance to the habitat and resident biota;
2. As primary producers, they are most directly affected by and are most sensitive to certain physical and chemical factors such as temperature, nutrients, and toxins;
3. Associations of stream algae normally consist of 30 to 50 species, each having unique environmental requirements and pollution tolerances; and
4. As with the common macroinvertebrates, the environmental requirements and pollution tolerances of most common algae in Montana are well known.

The accumulated dead and living algae in river periphyton communities ordinarily provide an integrated record of water quality conditions that exist since the start of substrate recolonization, which follows the substrate scour that occurs during snowmelt runoff. Since there was little or no scour in the Clark Fork River because of unseasonably low flows in the springs of 1987 and 1988, the periphyton samples collected in these years probably represent a somewhat longer period of history. However, due to periodic sloughing and regrowth of algae at the surface of the biofilm, the algae that are present and the conditions they represent may be weighted heavily toward the days and weeks immediately preceding sample collection.

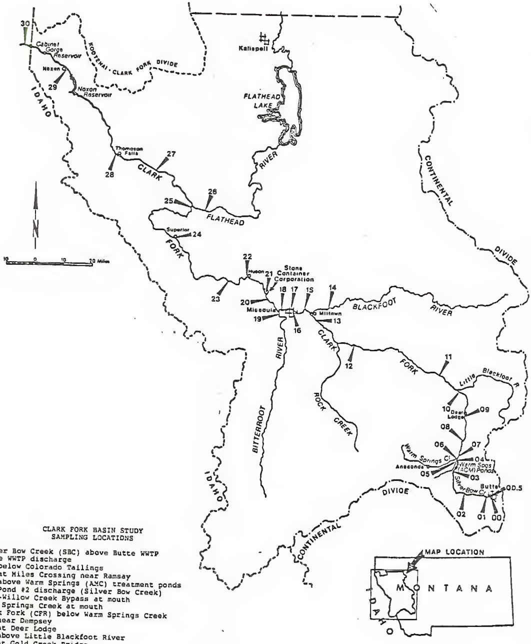
METHODS

Composite periphyton samples were collected from natural substrates at 25 ambient water quality monitoring stations on the Clark Fork River and selected tributaries (Figure 1). Samples were collected from August 10 through 14 in 1987 and from August 15 through 18 in 1988. Samples were collected according to Procedure 6.2.2 (Periphyton) in the Water Quality Bureau's Field Procedures Manual (WQB, 1989).

Each sample was processed as follows: Soft-bodied (non-diatom) algae were identified to genus under a light microscope at 400x. The relative abundance of each algal genus was estimated by volume, based on field notes nd microscopic examination.

The sample was then processed in concentrated sulfuric acid and potassium dichromate in order to oxidize and remove organic matter, leaving behind empty diatom frustules and other inorganic constituents. This "cleaned" material was mounted on a glass slide in Hyrax and examined under 1000x for diatoms.

Each slide was first scanned and a species list was prepared. Approximately 350 to 450 diatom frustules were then counted at random in each Hyrax mount and the percent relative abundance of each species was calculated. Total number of species, number of species counted and Shannon diversity were then calculated for each diatom association. Also calculated were the number and percent relative abundance of diatom species in the three pollution tolerance groups of Lange-Bertalot (1979).



CLARK FORK BASIN STUDY
SAMPLING LOCATIONS

*	00	Silver Bow Creek (SBC) above Butte WWTP
	00.5	Butte WWTP discharge
*	01	SBC below Colorado Tailings
*	02	SBC at Miles Crossing near Ramsay
*	03	SBC above Warm Springs (AMC) treatment ponds
*	04	AMC Pond #2 discharge (Silver Bow Creek)
*	05	Mill-Willow Creek Bypass at mouth
*	06	Warm Springs Creek at mouth
*	07	Clark Fork (CFR) below Warm Springs Creek
*	08	CFR near Dempsey
*	09	CFR at Deer Lodge
*	10	CFR above Little Blackfoot River
*	11	CFR at Gold Creek Bridge
*	12	CFR at Bonita
*	13	CFR at Turah
*	14	Blackfoot River near mouth
*	15	CFR below Milltown Dam
*	16	CFR above Missoula WWTP
	17	Missoula WWTP discharge
*	18	CFR at Shuffield's
*	19	Bitterroot River near mouth
*	20	CFR at Harper Bridge
	21	Stone Container Corporation wastewater discharge
*	22	CFR at Huson
*	23	CFR near Alberton
*	24	CFR at Superior
*	25	CFR above Flathead River
	26	Flathead River near mouth
*	27	CFR above Thompson Falls Reservoir
	28	CFR below Thompson Falls Dam
	29	CFR below Noxon Rapids Dam
	30	CFR below Cabinet Gorge Dam

Figure 1. Periphyton sampling locations (*).

RESULTS AND DISCUSSION

Non-Diatom Algae

The estimated relative abundance of diatoms and other algae are presented in Tables 1 and 2.

One or more genera of green algae and diatoms were found at each of the stations sampled. These two groups co-dominated algae associations in the streams that were surveyed. Blue-green algae were found at most survey sites and as a group ranked third overall in terms of algal volume. At least two of the common bluegreens recorded (Nostoc and Rivularia) are known to be nitrogen fixers. Red algae, euglenoid algae and chrysophytes were relatively unimportant components of the algae associations at the stations that were sampled.

The upper two stations on Silver Bow Creek had the smallest number of non-diatom genera (2), which were highly pollution-tolerant green and blue-green algae. Some recovery was noted at Miles Crossing and above the Warm Springs Ponds where the number of non-diatom genera doubled and tripled, respectively, with the addition of more pollution-sensitive genera.

Downstream from the Warm Springs Ponds, increasing numbers of pollution-sensitive non-diatom genera demonstrate a steady improvement in water quality. Stations between Warm Springs Creek and the Blackfoot River averaged 7.5 genera; stations between the Blackfoot and Bitterroot Rivers averaged 9.2 genera; and stations between the Bitterroot and Flathead Rivers averaged 10.2 genera.

Relatively clean-water tributaries probably played a role in this downstream recovery. Warm Springs Creek, the Blackfoot River and the Bitterroot River each had more genera of non-diatom algae than adjacent sites on the mainstem. Some increase in diversity was also recorded from above to below the Little Blackfoot River although the reverse was true for diatoms. Among the tributaries, only Silver Bow Creek and the Mill-Willow Bypass had smaller numbers of non-diatom genera than the mainstem, which indicated a degree of water quality impairment.

Table 1. Estimated relative abundance (by volume) of diatoms and genera of other algae in periphyton samples collected from the Clark Fork River and tributaries, August 10-14, 1987

ALGAE	STATION 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
CHLOROPHYTA (green algae)																									
Ankistrodesmus sp.						R	R								R								C	A	
Botryococcus sp.							R																		
Chaetophora sp.															C										
Cladophora sp.					A		C	A	A	A	A	VA	VA	VA		VA	VA	A	VA	A	VA	VA	VA	VA	A
Closterium sp.							R					R	C	C	C	C	C	C	C	C	C	C	C	C	C
Cosmarium sp.				C	R		R	C	C	C	C	C		C	C	VC	VC	VC	C	C	C	C	C	C	C
Enteromorpha sp.												A													
Gongrosira sp.																			A	VC					
Hormidium sp.	VA		C	C																				R	R
Mougeotia sp.							R								VC						VC				
Oedogonium sp.							R												C						
Pediastrum sp.					C			C	C	C					C	C	C	C	C	C	C	C	C	C	C
Planktosphaeria sp.																			C	VC	C	C	C	C	C
Scenedesmus sp.			C	VC	C	VC	C			C	C	C		C	C	C	C	VC	VC	VC	C	C	C	C	VC
Spirogyra sp.															A		VA	VA			VC			C	
Stigeoclonium sp.		VA	A	C	A	A	C	A	VA	A	C			C				A		C	VA	VC		VC	
Tetraspora sp.						A																			
Ulothrix sp.																			R						
EUGLENOPHYTA (euglenoid algae)																									
Euglena sp.						R																			
CHRYSOPHYTA (yellow-green algae)																									
Vaucheria sp.											VC														
BACILLARIOPHYTA (diatoms)	A	VA	A	A	VA	VA	VA	VA	VA	VA	VA	VA	A	VA	A	VA	VA	VA	VA	VA	VA	VA	VA	VA	VA
CYANOPHYTA (blue-green algae)																									
Merismopedia sp.																	R		C						C
Nostoc sp.						C	VC		VC	VC	VC	A	VC	VC	VC		C		A				A	A	
Oscillatoria sp.				VC	VC	VC		C		C		C		R											
Phormidium sp.					VC			VC	VC			C			A	VC		VC							
Rivularia sp.											R	VC	VC	C	VC	R	C	C					VC	A	VC
Synechocystis sp.	A	A	A	VA																					
RHODOPHYTA (red algae)																									
Audouinella sp.							C							VC	R			C					VC	VC	
TOTAL NON-DIATOM GENERA	2	2	4	6	7	7	11	6	6	7	7	9	4	9	12	7	9	10	11	8	9	7	10	13	9

R = rare; C = common; VC = very common; A = abundant; VA = very abundant

Table 2. Estimated relative abundance (by volume) of diatoms and genera of other algae in periphyton samples collected from the Clark Fork River and tributaries, August 15-18, 1988

ALGAE	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
CHLOROPHYTA (green algae)																									
Ankistrodesmus sp.							C		C	VC		R	C	C	VC	C	C	C	VC		VC	VC	C	VC	VC
Bulbochaete sp.															R										
Chaetophora sp.															A				VC						
Cladophora sp.					VA	A	A	A	A	A	A	A	A	A		R	VC	VC	C	A	VC	A	A	VA	A
Closterium sp.					C		C				R	C	C		C	C	C	C	C	C	VC	C	C	C	C
Cosmarium sp.			R	VC	C	C	C	R	R	C					C	C	C	C	C	C	C	VC	C	C	C
Enteromorpha sp.										A															
Gongrosira sp.																			C						VC
Hormidium sp.	VA		VC				VC																A	A	
Mougeotia sp.							VC		R																C
Oedogonium sp.					R		VC	A		C		VA	VA			A									
Pediastrum sp.					C	R	R	C	VC	VC	C		C		C	C	C	C	C	C	C	C	C	C	C
Planktosphaeria sp.																			C		C	R			
Scenedesmus sp.			C	C	C	C	C	VC	VC	VC	VC	R	C	C	VC	C	C	C	VC	VC	VC	VC	VC	VC	VC
Spirogyra sp.															A	VC	A		VC		C		C		A
Stigeoclonium sp.		VA	C	VC	C	VA	VC		C		R	VA		VA			C	A		A	A	A	A	A	A
Ulothrix sp.						VC																			
CHRYSOPHYTA (yellow-green algae)																									
Tribonema sp.							C																		
BACILLARIOPHYTA (diatoms)	A	A	A	C	VA	VA	VA	VA	VA	VA	VA	VA	VA	VA	A	VA	VA	VA	VA	VA	VA	VA	VA	VA	VA
CYANOPHYTA (blue-green algae)																									
Nostoc sp.						A	R			VC	VC	VC	A	VC	VC							R	VC	VC	
Oscillatoria sp.				C	VC					VC	C			C				C				R			
Phormidium sp.				VC			C					VC	VC	C	A	C		A	VA	VC	A	VC	VC	VC	A
Rivularia sp.											VC	VC	VC	VC	VC	C						R	C	C	VC
Synechocystis sp.	A	C	VA	VA												VC									
Tolypothrix sp.															R										
RHODOPHYTA (red algae)																									
Audouinella sp.												A		A	R		VC					R	R	VC	VC
TOTAL NON-DIATOM GENERA	2	2	5	6	8	7	13	5	7	9	8	10	9	9	13	11	9	9	11	7	10	13	13	12	13

R = rare; C = common; VC = very common; A = abundant; VA = very abundant

Cladophora was the dominant non-diatom alga in the Clark Fork River in both years, although it was significantly less abundant in 1988. (The 1988 collections were made somewhat later than they were in 1987 and after a certain amount of sloughing had occurred.) From personal observations, Cladophora was most abundant from Gold Creek to Turah in 1987; in 1988, Cladophora abundance was more evenly distributed along the river.

Stigeoclonium, a filamentous green alga that is tolerant of pollution, was most abundant in Silver Bow Creek and the upper river and again downstream below major point sources of nutrients (Missoula and Stone Container). The two genera of nitrogen-fixing blue-green algae (Nostoc and Rivularia) were most abundant from Deer Lodge to Turah and in the Blackfoot River. During August these sites typically have inorganic nitrogen to ortho phosphate ratios of less than 2 (Water Quality Bureau, unpublished data), indicating relative nitrogen deficiency.

Diatoms

The percent relative abundance (PRA) of diatom species and other statistics calculated for the diatom associations of the Clark Fork River and tributaries are presented in Tables 3 and 4.

Between 4 and 45 species were counted in each of the diatom associations that were sampled; corresponding Shannon diversity values ranged from less than 1.00 to well over 4.00. In general, unpolluted waters have more than 25 species counted and Shannon diversity values greater than 3.00 (Bahls, 1979).

Based on these criteria, species richness and diversity data from all four Silver Bow Creek stations demonstrate severe environmental stress. The high proportion of pollution tolerant diatoms in Silver Bow Creek below the Butte WWTP indicates that the source of this stress was pollution. The environmental requirements of the dominant diatom species in Silver Bow Creek (Lowe, 1974) indicate that the principal causes of pollution are excess nutrients and heavy metals below the Butte WWTP, and heavy metals alone above the Butte WWTP.

Borderline species richness and diversity values, the relatively high proportion of pollution tolerant diatoms, and the presence of indicator species indicate moderate pollution and use impairment from the Warm Springs Pond #2 discharge downstream to Bonita, including the Mill-Willow Bypass and Warm Springs Creek. Slight impairment is indicated at all other locations, including the Blackfoot and Bitterroot Rivers.

Achnanthes minutissima was a dominant diatom species at most stations in the Clark Fork River and its tributaries. A. minutissima is a cosmopolitan species that is very tolerant of heavy metals pollution but intolerant of organic pollution and low oxygen content. Hence Lange-Bertalot (1979) lists this species as "sensitive," even though it tolerates high concentrations of heavy metals as it does in Silver Bow Creek.

Cocconeis pediculus, Cocconeis placentula and Epithemia sorex are three common Clark Fork species that live as epiphytes attached to filaments of Cladophora. It is not surprising then that the relative abundance of these species closely followed the relative abundance of Cladophora in the river.

Epithemia sorex has the additional distinction of harboring unicellular, nitrogen-fixing blue-green algae within its cell walls (Bahls and Weber, 1988). The three algae living in close proximity (Cladophora, Epithemia sorex and the unicellular bluegreen) may compose a mutually beneficial symbiotic relationship when and where phosphorus levels are high and inorganic nitrogen to ortho phosphate ratios are low.

Epithemia sorex achieved its greatest abundance between Gold Creek and Turah, which is within the range of greatest abundance for the two common free-living nitrogen-fixing bluegreens, Nostoc and Rivularia. These sites had among the lowest N:P ratios on the river (Water Quality Bureau, unpublished data). The August samples were also collected at a time when N:P ratios were at or near their lowest seasonal values (Water Quality Bureau, unpublished data).

Cymbella affinis achieved dominance below the Bitterroot River. This diatom apparently has a competitive advantage in warmer, nutrient-rich waters but is still considered a clean-water species (Lange-Bertalot, 1979). The large number of cells of this species at the Harper Bridge station in 1988 was the main reason for the depressed Shannon diversity value at this site.

Navicula atomus and *Navicula minima* were co-dominants in Silver Bow Creek below the Butte WWTP and both are tolerant of heavy metals and organic pollution. *Nitzschia palea* and *Nitzschia paleacea* prefer high nutrient levels but cannot tolerate heavy metals. These species reached their greatest relative abundance in and below the Pond #2 discharge. The nutrient-loving species *Synedra ulna* achieved its peak relative abundance values in the upper river and again below the Missoula and Stone wastewater discharges.

Table 3. Percent relative abundance (by cell numbers) of diatom species in periphyton samples collected from the Clark Fork River and tributaries, August 10-14, 1987. The letter "P" means the species was observed to be present at that station -- during a floristic scan -- but it was not encountered during the diatom proportional count.

SPECIES[1]	STATION 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Achnanthes clevei (3)															.5		.3		.5			.2			.3
A. deflexa (3)						.8	.8	.3		.2					.3				3.8		.8	.2		P	1.4
A. lanceolata (2)	.3	P				5.2		.3	.5	1.1	.3	.2	.7	1.1	1.4	.6	.3	.8	1.6	1.1	1.0	1.7	1.1	.3	3.1
A. lapponica (3)																									.3
A. minutissima (3)	52.6	4.8	18.8	18.1	.7	28.4	61.6	2.1	2.5	19.0	9.5	3.4	1.2	3.8	17.4	8.4	8.1	8.7	22.7	3.8	4.1	2.0	12.0	7.1	8.5
Amphipleura pellucida (3)														1.1	1.1										
Amphora coffeiformis (1)			.2	.3																					
A. libyca (3)									P						P										
A. pediculus (3)												.5	1.0		1.9	P	1.2		.3	.3	P	.2	2.4	2.1	2.8
A. veneta (1)					4.9			6.2	1.5	.7													.8		
Anomoeoneis vitrea (3)																									P
Caloneis amphisbaena (2)																P									
C. bacillum (3)	P			P		.3				.4	.3	.2			P		.3								
C. sp. (3)				.3							.3														
Cocconeis pediculus (3)							.5		3.7	.7	.5	1.5	3.2	7.4	P	7.8	6.1	.8	1.6	P		.2	3.5	3.2	.6
C. placentula (3)				.3	2.2	.3	P	2.1	4.7	5.4	7.8	19.2	22.2	21.0	7.1	7.3	10.8	3.4	8.6	4.1	6.4	3.5	10.6	17.9	11.6
Cyclotella meneghiniana (2)	.3				.5	1.0	2.1	1.8	2.0	4.8	3.8	4.1	.5	1.4	P	.6	1.7	1.1	P	.8	1.8	1.2	4.0	6.3	6.5
C. sp. (2)							.3							.3											.9
Cymbella affinis (3)							4.7	P					.5	.3	3.5	5.0	1.7	30.9	11.6	39.5	35.0	38.2	10.1	6.3	6.3
C. amphicephala (3)							P																		
C. caespitosa (3)						P	.3	.5	.5		.3			.3	1.4	.3	.6	.3		.3				.5	1.1
C. cistula (3)							P												4.0	P					
C. mesiana (2)															.3										
C. mexicana (3)															.3	P	P	P	.3						.3
C. microcephala (2)							5.5			P					22.6	.3	.6				P		.5		2.3

Table 3. Continued.

SPECIES[1]	STATION 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Cymbella minuta (2)			.5			1.8	6.1	.3	3.7	9.9	6.8	1.0	1.7	3.6	1.4	2.2	.3	.6	5.9	.8	1.8	1.0	1.3	P	.6
C. prostrata (3)																		P							
C. reichardtii (2)										.7	.3								.3						
C. rupicola (3)							P																		
C. sinuata (3)						.3			.7	2.8	2.0	1.5	1.2	1.1	.3	1.7	.6	1.7	1.4	.8	2.0	4.7	2.4	2.6	2.8
C. subaequalis (3)							P																		
C. tumida (3)																								.3	
Cymtopleura solea (2)										.2		P	.2		P	P									
Denticula sp. (3)										.2															
Diatoma hiemale (3)																P								P	
D. tenue (2)						P				.2								.3							
D. vulgare (3)							P	P	29.1	.2	P	.2	.2	.5		1.7	4.1	2.2	3.8	4.1	4.3	6.0	3.2	1.2	1.7
Epithemia adnata (3)														.3	.5		.9		P					.5	
E. sorex (3)				P	6.3	.8		P	.5		1.3	20.9	37.8	19.7	4.9	10.4	15.4	7.6	.8	1.1	1.0	4.2	7.7	18.7	1.1
E. turgida (3)															.5	P	.3		.3					2.6	.6
Fragilaria brevistriata (3)																.6						.2			
F. capucina (2)					2.2	4.4	5.3	3.8	9.1	3.7	.5	.7	.7	.8		.3	.3			.6	.3		.8		
F. construens[2] (3)			.2		2.4	3.9	2.4		1.2	4.5	2.3	1.9	2.5	4.9	10.9	7.0	4.7	5.1	2.2	5.2	3.1	3.7	4.8	8.2	17.3
F. crotonensis (3)							P	P												.3					
F. vaucheriae (2)			P	.3											.5	1.7	1.6	.6	.3	P		.2	.5	.3	2.3
F. virescens (3)			.2																						
Gomphoneis herculeana (3)																				P					
G. sp. (3)																									.6
Gomphonema angustatum (3)		P																					P		
G. clavatum (3)					.7				.3										.3						
G. clevei (3)																			.3						
G. gracile (3)													.5			.3									
G. minutum (3)													.5	.3	2.5	12.3	10.5	1.7	2.4	.8	.8	1.0	2.1	.8	.9

Table 3. Continued.

SPECIES[1]	STATION 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Gomphonema olivaceum (3)								.5	.7	.4	1.3	1.0	1.7	.8	.8	1.7	.6	.3		.3	.3	P			.6
G. parvulum (1)					.2	7.8		1.5	2.2	3.5	4.8	2.4	.5								P				
G. truncatum (3)									P																
G. ventricosum (3)															P				P						
G. sp. (3)			.2					.3							.6			.3		.8					.3
Gomphonitzschia sp. (3)													.5												
Hannaea arcus (3)								.3								P									
Melosira granulata (3)					.2																				
M. varians (2)							P		.5		.3						.3	.6	.3	P	.3		.3		
M. sp. (3)																.3								.3	
Meridion circulare (3)										.2						P									
Navicula accomoda (1)																		.3							
N. arvensis (1)		.3		P		2.1		P		.2	.3	.5		.3		P									
N. atomus (1)	34.1	94.5	63.9	50.1		.8		.8	.5	.7	2.3	1.0	.5					.6		.3				.3	
N. aurora (3)															P										
N. bryophila (3)															4.4										
N. capitata (2)																				.3	P	P	P		
N. capitatoradiata (2)							P				.5	.5	P	2.7	1.9	3.1	4.1	3.9	4.6	7.9	6.9	4.2	3.7	1.8	5.1
N. cryptocephala (2)		P			P	P	.3	P				6.6					P				P				
N. cryptotenella (2)				P		.3	2.6	.5	2.7	6.5	10.0		4.7	2.7	.8	1.7	4.7	3.9	1.6	.6	1.5	1.0	1.3	2.6	1.7
N. decussis (3)	.5	P				P			.5	1.9	.5	.2		P	.5		P	P		.3	.3	.5	.5		
N. gregaria (2)			P							.4												.2			
N. ignota (2)																							.5		1.1
N. laevissima (3)										.2															
N. lanceolata (2)		P								P							P								
N. menisculus (2)		P												.3	1.4	.6		P	.3					.3	.9
N. minima (1)	11.3	.2	14.6	26.9	2.2	9.4	.3	1.3	2.0	3.5	13.3	8.0	.7	.5	.5	.3	P			.3	P		.3	.3	.3
N. pupula (2)		P								.2	.3	.2	.2	P					P			.2	P		
N. radiosa (2)															P	.3	.6		.3						

Table 3. Continued.

SPECIES[1]	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Navicula subminuscula (1)		P																							
N. tripunctata (3)							.3				.3	.7	P	P	.5	.8	.9	P	.3	.8	.5	2.2	1.6	.5	.3
N. trivialis (2)										P	.3			.3											
N. veneta[3] (1)							.5			1.5	.3	1.2	.2	1.1	.5	.6	.6	.3		.6	.5	1.0	.3		1.1
N. sp. (2)						P		1.0			.3			.3			.3		.3	.3	.6				.3
Neidium dubium (3)										.4						P									
Nitzschia acicularis (2)		P				P	.3	P	.3	.7	.3									.6	.5		.8	.3	
N. amphibia (2)					4.1			.5	.5	.4	2.3	.2													P
N. angustata (2)															.3										
N. constricta (2)											P														
N. cummunis (1)						.3																			
N. dissipata (3)						2.6	P		1.0	1.3	2.3	1.5	.7	.8	.5	1.4	2.3		.3	.3	.3	1.0	.3	.3	2.0
N. fonticola (3)					35.3	4.7	1.3	28.7	4.9	2.2	4.8	1.9	1.0	2.7	1.9	2.2	2.6	8.4	4.1	5.8	6.7	2.5	5.6	1.6	1.4
N. frustulum (2)												.2						1.4		.6		P		.3	
N. gracilis (2)														.3		.8									
N. incognita (2)										.2															
N. inconspicua (2)					7.5	1.3		.8	.3	1.7	13.0	10.2	2.7	3.8	.3	1.7	2.3	2.8	1.4		2.3	3.0	4.5	2.9	2.0
N. intermedia (3)							P																		
N. linearis (3)						3.9	.8	.5	2.2	2.6	.8	.7	P	P		.8	P			.6					
N. palea (1)	.3				6.1	10.4	1.3	2.8	4.0	3.5	2.3	.7	1.5	2.2	.3	1.1	.9	3.7	.5	.8	1.8	.7	.5	.8	.9
N. paleacea (2)					21.9	4.7	1.3	37.4	6.7	8.6	6.5	5.8	3.7	4.6	1.1	4.2	7.0	6.7	1.9	8.2	6.1	2.5	8.0	7.1	1.1
N. pumila (2)															1.1										
N. sigmoidea (3)													.2												
N. sp. (2)		.2					.3				.3	.2	.5	.3	1.5				.3						
Pinnularia microstauron (2)										.2															
P. sp. (3)												.2	.2												
Rhoicosphenia curvata (3)	.3				1.5			P		.2		P	4.7	6.8		6.2	1.6	.6		.3		.2	.5	.5	
Rhopalodia gibba (3)					.2	2.1		P					P		.3										
Simonsenia delognei (2)													.5	.3											
Stauroneis phoenicenteron (2)																									.3

Table 3. Continued.

SPECIES[1]	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Stephanodiscus subtilis (2)																									P
Surirella angusta (2)	.3	P	1.0	3.1		.5				.4	.3	P						.3							
S. ovata (2)	P	P	P	.6		1.3		P	1.0	.2	1.5		P			P					.3				
Synedra filiformis (3)							.5																		
S. mazamaensis (3)														P	.3	P		P	.3	P					P
S. parasitica (2)															.3	.6	P								
S. ulna (1)					.7	.8	.5	7.2	11.6	3.5	1.3	.2	.2	1.4	1.9	2.2	2.9	.3	10.8	7.1	9.0	14.0	3.5	1.8	6.5
unknown genus (2)																						.2			
No. Most Tolerant Species (1)	4	3	3	4	5	7	4	7	6	8	7	7	6	5	4	5	4	5	2	5	5	3	5	3	4
No. Less Tolerant Species (2)	4	9	5	4	7	13	11	12	10	22	17	14	12	16	16	17	16	12	14	13	15	13	16	11	17
No. Sensitive Species (3)	4	3	4	5	8	13	21	14	17	17	17	17	22	20	30	27	23	20	24	23	15	18	16	20	24

Table 3. Continued.

	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
PRA Most Tolerant Species (1)	45.7	95.0	78.7	77.3	14.1	31.6	2.6	19.8	21.8	17.1	24.6	14.0	3.6	5.5	3.2	4.2	8.6	5.2	11.3	9.1	11.3	15.7	5.4	3.2	8.8
PRA Less Tolerant Species (2)	.9	.2	1.5	4.0	36.2	20.5	24.1	46.4	27.3	40.1	47.6	29.9	16.1	22.8	33.8	18.7	24.1	23.0	19.1	21.8	23.4	15.4	27.3	22.2	28.2
PRA Sensitive Species (3)	53.4	4.8	19.4	18.7	49.5	48.1	73.2	35.3	52.5	42.8	34.3	55.5	79.8	71.8	62.9	76.2	73.6	72.0	69.9	69.5	65.6	70.7	67.3	75.2	62.8
Total Species	12	15	12	13	20	33	36	33	33	47	41	38	40	41	50	49	43	37	40	41	35	34	37	34	45
Species Counted	10	4	9	9	20	23	26	27	31	45	39	35	34	36	43	37	36	31	36	35	30	32	33	32	42
Frustules Counted	390	420	410	353	411	384	380	390	405	463	399	411	405	366	367	357	344	356	370	365	391	401	376	380	352
Species Diversity (Shannon)	1.544	0.334	1.475	1.750	3.029	3.740	2.418	2.803	3.841	4.376	4.156	3.833	3.316	3.959	4.044	4.417	4.286	3.742	3.977	3.450	3.589	3.581	4.327	3.922	4.411

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[1] Number in parentheses is pollution tolerance index: 1 = most tolerant; 2 = less tolerant; 3 = sensitive. Source: Lange-Bertalot 1979.

[2] *Fragilaria construens* encompasses specimens identifed as *F. construens*, *F. leptostauron* and *F. pinnata*.

[3] Sensu *N. cryptocephala* var. *veneta* (Kutz.) Rabh. of Patrick and Reimer (1966) (Plate 48, Fig. 5) and *Navicula* sp.2 of Krammer and Lange-Bertalot (1986) (Fig. 33).

Table 4. Percent relative abundance (by cell numbers) of diatom species in periphyton samples collected from the Clark Fork River and tributaries, August 15-18, 1988. The letter "P" means the species was observed to be present at that station -- during a floristic scan -- but it was not encountered during the diatom proportional count.

SPECIES[1]	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Achnanthes clevei (3)																	P			P	.3		P		P
A. deflexa (3)							.3			1.9					1.3				2.3	.5	P				1.4
A. lanceolata (2)	1.0	.5	.3	1.0		1.4	.6		.5	.2	1.0	.8	.9	.2	.5	.9	.6	.6	1.8	.8	1.4	P	.3	1.0	1.4
A. minutissima (3)	79.5	12.7	8.9	20.3	1.4	12.1	19.5	2.3	1.5	64.6	7.9	.3	.2	2.1	17.8	5.7	11.7	5.6	10.4	1.3	4.2	1.9	3.5	2.0	21.9
Amphipleura pellucida (3)															.3										
Amphora pediculus (3)							.3				2.6	.5	2.2	2.6	1.3	.6	.3	.3	3.7	.5	1.7	8.0	.5	1.2	.3
A. veneta (1)					4.4	.3		5.4	P									P							
Caloneis amphisbaena (2)																									
C. bacillum (3)				P					P	.2	.7														
C. sp. (3)																	.3								
Cocconeis pediculus (3)							9.1	2.8	.3		.5	11.6	.4	9.7	.3	.6	.9	P	.3	P	.8	P	16.2	4.9	P
C. placentula (3)	P		.3	P	.3	.6	4.1	7.9	2.5	.9	7.4	9.8	5.1	24.7	2.5	3.0	3.7	2.5	8.1	1.1	6.1	6.2	14.2	8.8	5.7
C. thumensis (3)																									.3
Cyclotella meneghiniana (2)	P	.2		.2		9.4	.6	1.8	2.5	.7	.7	.3	.2	.2		P	.3	P	.3	P	.6	1.1	1.8	4.9	1.6
C. stelligera (2)																									.5
C. subtilis (2)																								.2	.3
Cymbella affinis (3)							.6		.5					4.5	13.7	40.1	25.1	24.4	14.9	54.5	13.1	23.9	6.1	1.7	8.1
C. amphicephala (3)									P																
C. caespitosa (3)								.5		P							.3						.3		.5
C. cistula (3)						.3													.5						
C. delicatula (3)																									.3
C. mexicana (3)																P	.3			P	P				
C. microcephala (2)							1.5		P	P			.2		38.4	1.2	1.7	P			.3		.3		4.6

Table 4. Continued.

SPECIES[1]	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Cymbella minuta (2)				P		5.5	2.7	P	1.5	1.7	1.0	.3	.4	.7	1.3	1.2	.6	.3	5.7	.3	.6	.3	1.3	P	.3
C. prostrata (3)																					P				
C. reichardtii (2)										.2															
C. sinuata (3)					.3		.9		.3	P	1.0	.3	.7	P	.8	P	.3	.8	3.1	1.1	.3	8.0	1.3	2.2	2.2
Cymtopleura solea (2)								P									P								
Denticula sp. (3)										.2															
Diatoma hiemale (3)			P				.3											P							
D. tenue (2)																									P
D. vulgare (3)						.8		.5	.5	P		P	1.1	P		2.7	2.6	P	.5	1.3	8.9	12.6	.5	.5	2.2
Epithemia adnata (3)														.2	.5										
E. sorex (3)					P	P	.3		8.8		2.9	39.6	24.3	15.0	.5	3.6	5.4	.3	.3	P	9.2	11.8	12.7	31.1	1.9
E. turgida (3)																	.6							6.1	3.0
E. sp. (3)					.3																				
Fragilaria brevistriata (3)																.6						.3			
F. capucina (2)		12.7	1.3	2.7	8.6	15.2	1.5	2.8	1.5	1.7	2.4	3.3	1.3	1.0	2.0			.3			P				
F. construens[2] (3)	.5		1.8	P	.3	4.1	2.4	6.1	3.8	1.9	3.1	2.3	3.7	6.2	4.5	6.6	9.7	6.1	6.0	2.7	7.5	5.9	7.8	8.8	8.6
F. crotonensis (3)						.6																			
F. vaucheriae (2)															2.0	2.4	2.3	.6	2.9	.5	P	.3	.5	.7	2.2
Gomphoneis sp. (3)																					P	.3			
Gomphonema angustatum (3)						.3																			
G. clavatum (3)								1.0											.3						
G. clevei (3)									P										.3						
G. gracile (3)																.3									
G. minutum (3)					2.5	.3	.3					.3	.9	.7	1.0	.9	.3	.6	5.7	P	.6	.5	1.5	.2	1.1

Table 4. Continued.

SPECIES[1]	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Gomphonema olivaceum (3)							.6	.3	19.1	4.0	1.2	1.5	2.0	1.7	.3	1.2	.3	.3					P		
G. parvulum (1)	P	1.7			1.1	6.6	1.2	4.6	.5	1.7	2.6	.5	1.1			P	P								
G. truncatum (3)					1.9			.3	1.0																
G. ventricosum (3)																									P
G. sp. (3)																		.3	.5					.2	.5
Hannaea arcus (3)																		P					.3		
Melosira granulata (3)						.3																			
M. varians (2)								10.2								P					.6				
Meridion circulare (3)		P						.3								.3	P	P							
Navicula arvensis (1)						.6		.5	.3		.2				.3										
N. atomus (1)	15.7	61.3	59.7	42.4	.3			.3	.5	.5	.5	.3	.9	.2										.2	
N. bryophila (3)															.8										
N. capitatoradiata (2)							2.7		.3			.3		1.4	1.3	1.2	4.6	12.5	2.9	7.4	10.3	4.8	3.8	3.2	.8
N. cryptocephala (2)					.3			P																1.2	.3
N. cryptotenella (2)					P	.8	2.7	3.8	3.3	4.5	2.3	1.5	4.3	1.7	.5	1.8	4.9	6.1	1.8	3.7	2.8	2.7	1.3		1.6
N. cuspidata (2)								.3																	
N. decussis (3)	P	P				P		.3	.5	.7	.2		.2	.2			.3		.5	.3	.3		P	.5	.3
N. gregaria (2)	P																								
N. ignota (2)																			.3						
N. lanceolata (2)														.2		P	.6						.3		P
N. menisculus (2)															.3						.3			.2	P
N. minima (1)	.3	6.7	25.3	30.3	.3	.6	.3	.5	1.3	2.8	11.2	1.0	2.9	.5	.3	.3	.3		.5		.3				
N. pupula (2)	.3							P	.3	P	.5			P		P	.3				.3				
N. radiosa (2)														P	.3									.2	
N. seminulum (1)																.3									
N. tripunctata (3)							2.7	.5				.3	.4	.7		.3	.6	P	.3	1.9	3.3	8.0	1.0	1.0	.5
N. trivialis (2)			P					.3	P															.2	
N. vanheurckii (3)																								.2	
N. veneta[3] (1)			.3		.3		P	P		.5	.2	.5	P	1.0	.3	.6	.3	1.9	.5	.3	.3	P	.5	P	.5
N. sp. (2)		.2	.3				.3		.3		.2		.2		.3			.3	.3						

Table 4. Continued.

SPECIES[1]	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Nitzschia acicularis (2)	P			P		.3	.3	.3	1.0	P	P		.7	P		P		P	.8	.3			.8	2.7	
N. acula (3)															.3										
N. amphibia (2)					6.4			5.4	.5	.5	.2							6.1		P					
N. aurariae (2)						.3																			
N. dissipata (3)						.6	1.5	P	2.3	.9	3.1	.3	.9	.5	1.5	3.0	4.6	1.9	1.3	.5	.8	.5		.2	.3
N. fonticola (3)					34.8	1.4	6.2	9.7	8.7	.7	1.4	1.0	.7	1.9	.5	1.2	1.7	10.6	1.6	7.2	5.3	5.9	5.6	3.4	1.1
N. frustulum (2)												.3		.2				.6				P			.3
N. gracilis (2)									.5							P	.3	.8				P			
N. incognita (2)									5.0																
N. inconspicua (2)					2.5			2.6	.3	.7	28.5	5.0	3.8	5.7		.3		2.8	1.8	2.4	4.2	1.9	3.0	2.4	1.9
N. intermedia (3)							.3									.3	.6	P							
N. linearis (3)	P					1.7	.3	2.6	2.0	1.7	.7						.3	.3							
N. palea (1)	.5	.7	.3	.5	22.1	14.6	12.7	3.6	6.0	.9	1.2	P	.9	3.6	.3	1.8	P	4.2	.5	.5	.6	P	1.0	.2	.8
N. paleacea (2)				.2	4.7	11.0	11.5	15.1	4.8	.7	10.5	13.6	30.7	6.4	.3	13.2	4.9	11.7	6.5	4.0	1.7	5.6	10.4	6.8	2.4
N. perminuta (3)									.3																
N. pumila (2)															1.0										
N. pusilla (1)	.5			P	P		.3																		
N. sigmoidea (3)										.2															
N. sp. (2)						.8	1.8			.2			.4	.9	1.6										
Pinnularia microstauron (2)									.3																
Rhoicosphenia curvata (3)					4.1	P	P	2.6	.5	P	P	1.5	1.8	1.2		P		.6	.3	1.3	1.9	.3	1.0	.5	P
Simonsenia delognei (2)													.9	.5											
Surirella angusta (2)	1.3	2.4	1.8	2.0				P										P							
S. ovata (2)	.5	P	P	.2				.3	P							P	P	P		P					

Table 4. Continued.

SPECIES[1]	STATION 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
Synedra acus (2)																			.3						
S. filiformis (3)							.9			.2															
S. mazamaensis (3)															.3	P	.3	P						.2	
S. nana (3)																			.3					.5	.3
S. parasitica (2)							P													.3					
S. ulna (1)					3.3	9.9	9.1	4.6	9.1	4.2	1.4	3.3	5.6	1.2	2.0	3.6	7.1	.8	12.0	5.3	11.9	10.8	2.3	1.2	20.3
Thalassiosira pseudonana (1)																							.3		
No. Most Tolerant Species (1)	3	4	4	4	8	6	6	8	7	6	7	6	6	5	5	6	5	4	4	3	4	3	4	5	3
No. Less Tolerant Species (2)	7	6	6	7	6	9	12	16	18	13	11	9	11	15	13	15	14	16	12	12	14	9	10	12	16
No. Sensitive Species (3)	5	3	4	5	10	15	19	16	19	17	14	14	16	17	18	21	23	23	21	18	20	16	19	20	24

Table 4. Continued.

	STATION																								
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	18	19	20	22	23	24	25	27
PRA Most Tolerant Species (1)	17.0	76.7	85.6	73.2	31.8	32.6	23.6	19.5	17.7	10.6	17.3	5.6	11.4	6.5	3.2	6.6	7.7	6.9	13.5	6.1	13.1	10.8	4.1	1.6	21.6
PRA Less Tolerant Species (2)	3.1	16.0	3.7	6.3	22.5	44.7	26.2	42.9	22.6	11.1	47.3	25.4	44.0	19.1	49.8	22.2	21.1	42.7	25.4	19.7	23.1	16.7	23.8	23.7	18.2
PRA Sensitive Species (3)	80.0	12.7	11.0	20.3	45.9	23.1	50.6	37.7	52.6	78.1	32.7	69.3	44.6	71.9	48.2	71.0	70.2	54.6	61.2	74.2	64.3	94.1	72.5	74.2	60.5
Total Species	17	13	14	16	24	30	37	40	44	36	32	29	33	37	36	42	42	43	37	33	38	28	33	37	43
Species Counted	10	10	11	10	23	27	34	34	37	29	30	27	32	33	36	29	36	29	37	25	31	23	30	34	35
Frustules Counted	395	419	392	403	362	363	339	392	397	424	418	396	449	421	398	334	350	360	383	376	360	372	395	409	370
Species Diversity (Shannon)	1.028	1.802	1.654	1.937	3.047	3.678	3.982	4.219	4.137	2.437	3.716	3.072	3.467	3.852	3.254	3.415	3.885	3.703	4.207	2.750	4.058	3.548	3.909	3.806	3.890

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[1] Number in parentheses is pollution tolerance index: 1 = most tolerant; 2 = less tolerant; 3 = sensitive. Source: Lange-Bertalot 1979.

[2] *Fragilaria construens* encompasses specimens identifed as *F. construens*, *F. leptostauron* and *F. pinnata*.

[3] Sensu *N. cryptocephala* var. *veneta* (Kutz.) Rabh. of Patrick and Reimer (1966) (Plate 48, Fig. 5) and *Navicula* sp.2 of Krammer and Lange-Bertalot (1986) (Fig. 33).

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APPENDIX A

PERIPHYTON COMMUNITY STRUCTURE IN THE CLARK FORK RIVER AND ITS TRIBUTARIES

SUMMER 1986

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PERIPHYTON COMMUNITY STRUCTURE

Methods

Composite periphyton samples were collected from natural substrates at all 28 ambient water stations from August 11-21, 1986. Different substrates (e.g., rocks, silt, aquatic plants) were sampled in proportion to their importance at a given site. Algae were also collected from various water depths and at various current velocities. Samples were preserved with Lugols solution.

Soft-bodied (non-diatom) algae were identified to genus under a light microscope at 400x. Together with the diatoms, the relative abundance of each algal genus in each sample was estimated by volume, based on field notes and microscopic examination.

The periphyton samples were then processed in concentrated sulfuric acid and potassium dichromate in order to oxidize and remove organic matter, leaving behind empty diatom frustules and other inorganic constituents. This "cleaned" material was mounted on glass slides in Hyrax and examined under 1000x for diatoms. Each slide was first scanned and a species list was prepared. Between 358 and 451 diatom frustules were then counted at random in each Hyrax mount and the percent relative abundance of each species was calculated. Total species, species counted and Shannon diversity were then calculated for each diatom association. Also calculated was the percent relative abundance of diatoms in the three pollution tolerance groups of Lange-Bertalot (1979).

Results

Results of the periphyton composition analyses are presented in Tables 1 through 3.

The summer 1986 algal flora of the Clark Fork River and its major tributaries was dominated by green algae (Chlorophyta), diatoms (Bacillariophyta) and blue-green algae (Cyanophyta). Other groups represented were euglenoid algae (Euglenophyta), yellow-green algae (Chrysophyta), and red algae (Rhodophyta).

Cladophora was the most consistently abundant genus of non-diatom algae in the river. Peak abundance of this alga was registered from Gold Creek to Missoula and again in the reach between Superior and Flathead River. Other non-diatom algae were locally abundant or widely distributed up and down the river but in smaller number.

Diatoms were recorded at every station. Low species diversity and a large percentage of pollution tolerant diatoms indicate significant ecological stress in Silver Bow Creek and the upper Clark Fork River. Very low species diversity values were recorded at Turah and at Harper Bridge (between the mouth of the Bitterroot and the discharge from Stone Container). At each of these sites, however, there was a very small percentage of pollution tolerant diatoms, indicating relatively good water quality. A preponderance of Epithemia sorex and Cymbella affinis, both pollution sensitive species, was responsible for the low diversity values at Turah and Harper Bridge, respectively.

Table 1. Estimated relative abundance (by volume) of diatoms and genera of other algae in periphyton samples collected from the Clark Fork River and tributaries, August 11-21, 1986.

	STATION													
	01	02	03	04	05	06	07	08	09	10	11	12	13	14
CHLOROPHYTA (green algae)														
Ankistrodesmus sp.					R		R	C	R	R				
Botryococcus sp.														
Bulbochaete sp.														
Chaetophora sp.														C
Chara sp.														
Cladophora sp.				C			C	A	A	VA	VA	VA	VA	
Closterium sp.						R					R	R		
Cosmarium sp.				C	A	C	C	C	C	C		R		VC
Enteromorpha sp.									A	C		A		
Gloeocystis sp.					C	R		R						
Gongrosira sp.														VC
Hormidium sp.			C											
Mougeotia sp.														
Nephrocytium sp.						R								
Oedogonium sp.														
Palmella sp.	C	A	C											
Pediastrum sp.				R	R			R	R					
Protococcus sp.								R						
Rhizoclonium sp.					R									
Scenedesmus sp.	C	C	VC	R	A	VC	C	VC	VC	VC	C	C	C	C
Spirogyra sp.														A
Stigeoclonium sp.	VC	R	R	A	R		A	A		R		R	R	R
Tetraspora sp.				VC	R	VC								
Ulothrix sp.													C	R
EUGLENOPHYTA (euglenoid algae)														
Euglena sp.									R					
CHRYSOPHYTA (yellow-green algae)														
Dinobryon sp.														
Tribonema sp.			R		R						R			
BACILLARIOPHYTA (diatoms)	VC	C	VC	VA	VA	VA	VA	VA	VA	A	VA	VA	VA	VA

Table 1. Continued.

	STATION													
	01	02	03	04	05	06	07	08	09	10	11	12	13	14
CYANOPHYTA (blue-green algae)														
Chamaesiphon sp.					R									
Chroococcus sp.	VA	VA	VVA		VA		R							
Merismopedia sp.								R						
Nostoc sp.						VC	R	VC	VC	A	A	VC		
Oscillatoria sp.		R		VC	VVA	A	VC	C	R	C	C		R	
Phormidium sp.			R	VC	VC	C	VA			R		R		
Rivularia sp.				R							VC	C	A	A
Synechocystis											R			
Tolypothrix sp.														
RHODOPHYTA (red algae)														
Audouinella sp.						R					R	R	VC	R

R = rare; C = common; VC = very common; A = abundant; VA = very abundant; VVA = very, very abundant

Table 1. Estimated relative abundance (by volume) of diatoms and genera of other algae in periphyton samples collected from the Clark Fork River and tributaries, August 11-21, 1986.

	STATION													
	15	16	18	19	20	22	23	24	25	26	27	28	29	30
CHLOROPHYTA (green algae)														
Ankistrodesmus sp.	R					R			R	R	C	C	R	VC
Botryococcus sp.													R	
Bulbochaete sp.										VC				
Chaetophora sp.														
Chara sp.										VC				
Cladophora sp.	VA	VA	A	C	A	A	A	VA	VA		A			
Closterium sp.			R	C	R	R	R		R	R	R			R
Cosmarium sp.	VC	VC	C	C	VC	C	C	C	C	C	C	C	R	R
Enteromorpha sp.														
Gloeocystis sp.														
Gongrosira sp.											R			R
Hormidium sp.														
Mougeotia sp.										A	R	R	VC	VC
Nephrocytium sp.														
Oedogonium sp.					R							R		C
Palmella sp.														
Pediastrum sp.		R		C	R		R	R	R	R	R			R
Protococcus sp.														
Rhizoclonium sp.														
Scenedesmus sp.	R	C	C	VC	VC	C	C	VC	VC	C	C	C	C	C
Spirogyra sp.												R	VA	VA
Stigeoclonium sp.	C		R	R	C	C		R	A	C	C	C		VC
Tetraspora sp.														
Ulothrix sp.						VC								
EUGLENOPHYTA (euglenoid algae)														
Euglena sp.														
CHRYSOPHYTA (yellow-green algae)														
Dinobryon sp.														R
Tribonema sp.														
BACILLARIOPHYTA (diatoms)	VA	VA	VVA	VA	VVA	VVA	VVA	VVA	VVA	A	A	VA	VA	VA

Table 1. Continued.

	STATION													
	15	16	18	19	20	22	23	24	25	26	27	28	29	30
CYANOPHYTA (blue-green algae)														
Chamaesiphon sp.														
Chroococcus sp.														
Merismopedia sp.										C			R	
Nostoc sp.												R	C	VC
Oscillatoria sp.			C	A		C				A	C		R	
Phormidium sp.		R	C	VA	R		R					R	C	C
Rivularia sp.	VC	C	C				C	C	C	VC	C	VC		C
Synechocystis														
Tolypothrix sp.											C	A		VC
RHODOPHYTA (red algae)														
Audouinella sp.	C	C	VC				C							

R = rare; C = common; VC = very common; A = abundant; VA = very abundant; VVA = very, very abundant

Table 2. Percent relative abundance (by cell numbers) of diatom species in periphyton samples collected from the Clark Fork River and tributaries, August 11-21, 1986.

SPECIES	STATION											
	01	02	03	04	05	06	07	08	09	10	11	12
Achnanthes affinis											0.3	
A. clevei												
A. deflexa						2.0	0.3		2.1	0.2		
A. lanceolata	P	P	0.3		5.0	0.2	0.6	0.5	0.8	0.7	0.3	0.2
A. lapponica						0.2						
A. linearis												
A. marginulata					P							
A. microcephala												
A. minutissima	35.6	41.9	24.6		6.8	47.4	8.1	24.9	46.5	4.4	2.5	
A. pellucida												
A. peragalli												
A. subrostrata												
Amphipleura pellucida												
Amphora inariensis												0.2
A. libyca												0.2
A. pediculus												
A. veneta				13.6	0.2	0.2	5.9	0.5				
A. sp.												
Asterionella formosa												
Caloneis amphisbaena												
C. bacillum				0.3				0.7	0.3	0.4	P	
Cocconeis diminuta												
C. disculus												
C. placentula	P	P	1.3	1.3	1.4	0.2	0.3	2.5	P	1.6	11.1	4.8
C. pediculus		0.3						P	P	0.4	1.3	9.4
Cyclotella comensis												
C. kutzingiana												
C. meneghiniana	P				3.2	0.5	12.3	0.7	2.1	8.0	0.5	1.0
C. ocellata												
C. pseudostelligera												
Cymatopleura solea				P				P	P	P		

Table 2. Continued.

SPECIES	01	02	03	04	05	06	07	08	09	10	11	12
Cymbella affinis						0.2					0.5	0.2
C. caespitosa												
C. cistula												
C. delicatula												
C. descripta						1.0	P					
C. mexicana												0.2
C. microcephala						4.9						
C. minuta		P			12.1	9.3	5.0	3.2	4.5	0.9	1.0	P
C. prostrata												
C. reichardtii								1.0		1.1	0.3	
C. sinuata					0.5	1.2	0.6	1.0	1.9	1.6	6.3	0.5
C. sp.							0.3					
Denticula elegans									0.3			
D. sp.								P				
Diatoma tenue												
D. vulgare	P								0.3	0.4		P
Diploneis sp.												
Epithemia adnata												
E. sorex				0.3			P	0.2	P	7.5	35.4	65.9
E. turgida												0.2
Fragilaria capucina	4.5	1.0	0.3	1.3	3.2	0.7	1.7	2.7	5.1	7.3	1.5	1.2
F. construens	P	P			4.3	0.5	3.9	0.7	2.7	3.3	0.3	P
F. crotonensis												
F. leptostauron						0.5	P	P	0.5	0.2		0.2
Frustulia rhomboides												
Gomphoneis herculeana												
G. eriense	P											
G. septa												
G. sp.								P				
Gomphonema angustatum												
G. clavatum				1.5			P		P	0.2		
G. minutum												
G. olivaceum						1.0	0.8	1.2	0.5	0.9	2.5	1.5
G. parvulum	P			0.8	0.9	0.2	1.1	0.7	2.4	1.8	0.3	

Table 2. Continued.

SPECIES	STATION 01	02	03	04	05	06	07	08	09	10	11	12
Gomphonema pseudoaugur												
G. tergestinum												
G. truncatum							0.3					
G. sp.					0.5							
Hannaea arcus			P		P	P	0.6			P		
Melosira granulata				P								
M. varians					0.5		0.3					
M. sp.												
Meridion circulare			P			0.2						0.2
Navicula arvensis	0.3	P			1.6	1.0	P	P	0.3		P	
N. atomus	26.2	29.3	49.4	0.3	1.6	0.5	1.7	2.2	P	1.3		0.5
N. aurora												
N. bryophila												
N. capitata v. luneburgensis												
N. capitatoradiata	0.3										0.3	
N. cocconeiformis												
N. clementis		0.3										
N. cryptocephala					P		0.3	0.5				
N. cryptotenella						2.7	0.6	4.4	0.8	1.7	1.0	P
N. decussis	P				0.5			P				
N. difficillima												
N. elginensis												
N. exigua												
N. fracta												
N. gallica												
N. gregaria								P	0.3			
N. libonensis												
N. lanceolata					0.7			P			0.5	
N. menisculus				P		P					0.3	
N. minima	27.5	23.8	23.0	15.2	3.4	0.5	1.7	4.0	3.2	15.3	4.1	
N. mutica		P							P			
N. pelliculosa												
N. phyllepta												
N. pseudoscutiformis												
N. pupula					P			P	0.3	P		0.2

Table 2. Continued.

SPECIES	01	02	03	04	05	06	07	08	09	10	11	12
Navicula radiosa										P		
N. schoenfeldii												
N. subhamulata								P				
N. subminuscula												
N. subrotundata												
N. (tenelloides ?)												
N. tripunctata			P			0.5	0.3					
N. trivialis							P	0.2	P			
N. tuscula												
N. veneta				0.3		0.5		0.2	1.1	P	0.5	0.2
N. viridula												
N. sp.								0.2				
Neidium bisulcatum									P			
Nitzschia acuta					0.2							
N. acidoclinata		P										
N. acicularis					0.5	0.7	1.1	5.4	2.7	2.7	P	P
N. amphibia				17.7	P		1.1	P	P	0.7		
N. delognei												P
N. dissipata			P	P	1.4	4.2	0.6	5.7	3.7	6.7	1.3	1.9
N. frustulum				27.5	0.7	0.5	4.7	1.7	1.9	14.6	26.8	1.2
N. gandersheimiensis												
N. gracilis					0.5				P		P	
N. intermedia						0.2						
N. linearis		P	P		2.7	0.5	0.3	0.5	1.6	0.4	0.5	0.5
N. palea	4.3	0.3	0.3	1.0	13.0	2.0	17.3	15.1	5.6	3.3	P	1.0
N. paleacea		0.3	P	10.3	30.1	13.3	25.1	17.3	7.4	9.5	0.8	3.9
N. romana				P	P		0.6	1.0		1.8	P	0.7
N. sinuata												
N. sp #1												
N. sp #2												
N. sp.					1.4	0.2		0.2				
Pinnularia obscura		P										
Rhopalodia gibba					0.2							
R. gibberula			P									
Rhoicosphenia curvata	P			8.7	0.5		0.3			0.2	P	2.2
Stauroneis smithii												

Table 2. Continued.

SPECIES	STATION											
	01	02	03	04	05	06	07	08	09	10	11	12
Stephanodiscus astraea												
S. subtilis								P	P			0.2
S. sp.												
Surirella angustata	1.6	1.0	1.0		P	0.5	1.4	P	0.3	0.2		
S. ovata	0.3	2.0	1.3	P	2.7	0.5	0.6	0.5	0.8	0.4		
Synedra filiformis						0.2	0.3					
S. mazamaensis												
S. ulna		P		P	P	0.5	0.3	P	0.3	0.7		1.5
Tabellaria sp.												
Unknown						0.2						
Total Species	19	20	17	22	37	39	40	45	41	38	32	32
Species Counted	9	10	8	15	29	37	34	30	29	33	25	26
Frustules Counted	374	399	391	389	439	407	358	405	376	451	395	413
Species Diversity (Shannon)	2.107	1.871	1.702	2.869	3.629	3.051	3.664	3.633	3.232	4.073	2.885	2.177

P means present in the sample but not encountered during the proportional count.

Table 2. Percent relative abundance (by cell numbers) of diatom species in periphyton samples collected from the Clark Fork River and tributaries, August 11-21, 1986.

SPECIES	STATION											
	13	14	15	16	18	19	20	22	23	24	25	26
Achnanthes affinis						0.2						
A. clevei			P					0.3				1.9
A. deflexa		1.2			P	7.2	0.2	0.3	0.2	0.2		6.4
A. lanceolata	P		0.2			1.7	P	0.5	0.7	0.2	1.3	5.6
A. lapponica												P
A. linearis												0.3
A. marginulata												0.6
A. microcephala												
A. minutissima	1.1	19.7	6.8	8.4	3.6	24.0	2.2	3.1	4.7	19.5	29.6	22.6
A. pellucida												0.6
A. peragalli												P
A. subrostrata												0.3
Amphipleura pellucida		0.2		0.3								
Amphora inariensis												0.3
A. libyca												
A. pediculus		0.9	0.5	1.8	0.7	0.2	0.2		P	0.5	0.3	4.5
A. veneta												
A. sp.										0.5		
Asterionella formosa												P
Caloneis amphisbaena												
C. bacillum									P			
Cocconeis diminuta												3.9
C. disculus												0.3
C. placentula	3.2	12.3	7.5	5.6	1.8	12.7	0.9	3.1	4.5	5.0	3.5	5.0
C. pediculus	0.8	1.2	1.0	1.5		1.2		P	0.2			
Cyclotella comensis												
C. kutzingiana												
C. meneghiniana	P					0.5	0.2	0.3	0.7	0.5	1.8	
C. ocellata												4.7
C. pseudostelligera												

Table 2. Continued

SPECIES	13	14	15	16	18	19	20	22	23	24	25	26
Cymatopleura solea			P									
Cymbella affinis	18.5	14.3	17.3	7.7	64.4	4.6	78.9	57.3	51.9	23.6	5.3	4.2
C. caespitosa		0.5	0.2	P		P	0.2	0.5			0.3	0.3
C. cistula				0.3		0.2						
C. delicatula												0.3
C. descripta												
C. mexicana						P	0.2	P				
C. microcephala		3.2	P	0.3	0.2							5.6
C. minuta	P	1.2	1.0	1.3	0.2	4.1	P	0.5	0.2	P	0.8	0.3
C. prostrata						P						0.3
C. reichardtii			P		0.7	0.2						
C. sinuata	0.8	2.1	1.5	1.0		8.2	0.9	1.0	5.0	7.5	4.5	0.8
C. sp.												
Denticula elegans												
D. sp.												
Diatoma tenue			P	P								
D. vulgare	0.3	0.7	0.5	2.0	0.5	0.2	2.9	1.3	0.7	4.6	1.3	0.3
Diploneis sp.		0.2										
Epithemia adnata		1.2	0.5	0.5								
E. sorex	66.2	3.5	36.7	39.0	2.9		2.0	6.9	10.7	16.3	26.6	P
E. turgida		0.2		0.8	P					0.2	0.5	
Fragilaria capucina	0.5	2.8	1.9	4.3	0.7	1.0		0.8	0.2	1.0	0.5	4.2
F. construens	0.8	3.2	1.7	2.0	0.7	0.2	0.4	0.5	1.2	1.4	1.5	2.8
F. crotonensis												
F. leptostauron		1.6	0.7	0.8	0.2	0.2		P	P	P	1.8	2.5
Frustulia rhomboides												
Gomphoneis herculeana												
G. eriense				0.3	0.2	0.5	0.2	P	0.2		0.5	
G. septa		0.2										3.6
G. sp.		1.2										
Gomphonema angustatum				0.3		2.2	0.7	0.3				1.1
G. clavatum												
G. minutum						2.6			0.2	0.5	0.5	
G. olivaceum	0.8	1.2	1.2	2.3	1.1		P	0.3	P	0.7	0.3	P
G. parvulum			P		0.2							P

Table 2. Continued

SPECIES	STATION											
	13	14	15	16	18	19	20	22	23	24	25	26
Gomphonema pseudoaugur												
G. tergestinum										P	P	
G. truncatum												
G. sp.		1.6										
Hannaea arcus												
Melosira granulata												
M. varians						0.5		P				
M. sp.												
Meridion circulare									P			
Navicula arvensis					0.2	0.2						
N. atomus			0.2	0.3		0.2		0.3				0.3
N. aurora	0.3											
N. bryophila		0.2										
N. capitatoradiata		1.4	0.5	P	0.9	6.2	1.5	1.3	1.7	1.9	4.3	1.1
N. capitata v. luneburgensis												
N. cocconeiformis												
N. clementis												
N. cryptocephala						P	0.2					
N. cryptotenella		2.8	4.4	4.1	1.8	2.2	0.2	2.3	1.7	1.4	2.3	1.1
N. decussis						0.2	0.2					0.3
N. difficillima												
N. elginensis				0.3								
N. exiqua												
N. fracta												
N. gallica												
N. gregaria												
N. libonensis												0.3
N. lanceolata												
N. menisculus		0.2										P
N. minima						1.2	P	0.3				1.4
N. mutica												0.3
N. pelliculosa			0.5									
N. phyllopta												
N. pseudoscutiformis												P
N. pupula		0.2				0.2	0.2		P			0.3

Table 2. Continued

SPECIES	STATION											
	13	14	15	16	18	19	20	22	23	24	25	26
Navicula radiosa												
N. schoenfeldii						1.0	0.2	P		P		
N. subhamulata												
N. subminuscula						0.2						
N. subrotundata												0.3
N. (tenelloides ?)		0.2										
N. tripunctata	0.3	0.5	1.0	0.5	P	0.5	0.7	0.8	0.2	0.2	0.3	
N. trivialis						P						P
N. tuscula												P
N. veneta	1.1	1.4	0.2	0.5	0.7	1.0		0.5	0.7	1.0	0.3	0.3
N. viridula				P								
N. sp.		0.2		0.3								0.3
Neidium bisulcatum												
Nitzschia acuta												
N. acidoclinata												
N. acicularis			0.2	0.3		P		P		0.7	0.3	0.3
N. amphibia									P			0.3
N. delognei												
N. dissipata	0.8	2.8	1.2	1.8	1.8	0.5	0.9	3.6	1.7	0.5	1.0	1.1
N. frustulum	2.4	0.9	6.6	3.6	5.0	7.7	0.4	2.6	1.0	3.8	5.5	P
N. gandersheimiensis												
N. gracilis		0.5		0.3	0.5		P	0.3				
N. intermedia												
N. linearis				0.3	0.2		P	P	P			
N. palea		0.2				1.2	P	0.3	0.5	0.2	0.5	1.4
N. paleacea	1.6	5.8	3.9	3.3	9.5	3.1	0.2	3.6	1.5	3.6	2.8	3.9
N. romana		0.5		P	0.7	0.2	2.6	3.6	1.5	2.2	0.3	
N. sinuata												
N. sp. #1												1.9
N. sp. #2												0.6
N. sp.		0.2										
Pinnularia obscura												
Rhopalodia gibba	0.3		0.2	0.3	P							
R. gibberula												
Rhoicosphenia curvata		0.7	0.2	0.3	P	1.2	0.2	0.5	0.5	0.2		
Stauroneis smithii												

Table 2. Continued

SPECIES	STATION											
	13	14	15	16	18	19	20	22	23	24	25	26
Stephanodiscus astraea												
S. subtilis				0.3					0.5		0.3	
S. sp.												
Surirella angustata				P								
S. ovata			0.2	0.5	P							
Synedra filiformis												
S. mazamaensis		0.2	0.2	0.3	0.2							
S. ulna	0.3	6.0	1.0	2.8	0.5	0.5	2.2	3.6	6.5	1.9	2.0	1.7
Tabellaria sp.												P
Unknown												
Total Species	21	42	39	44	33	45	34	38	36	32	31	58
Species Counted	18	42	31	38	27	39	27	30	27	28	30	46
Frustules Counted	373	431	411	392	444	417	456	391	401	416	399	359
Species Diversity (Shannon)	1.804	4.188	3.295	3.606	2.271	3.990	1.595	2.752	2.827	3.489	3.365	4.439

P means present in the sample but not encountered during the proportional count.

Table 2. Percent relative abundance (by cell numbers) of diatom species in periphyton samples collected from the Clark Fork River and tributaries, August 11-21,1986.

SPECIES	STATION			
	27	28	29	30
Achnanthes affinis				
A. clevei	0.5	0.5	1.1	3.0
A. deflexa	1.0	0.3	1.1	2.2
A. lanceolata	0.2	1.6	12.0	7.6
A. lapponica				
A. linearis				0.3
A. marginulata				
A. microcephala	P			
A. minutissima	9.7	17.3	9.3	12.2
A. pellucida				
A. peragalli				
A. subrostrata				
Amphipleura pellucida	P	0.3	0.2	
Amphora inariensis	0.5			
A. libyca				
A. pediculus	1.0	1.8	1.6	2.7
A. veneta				
A. sp.				
Asterionella formosa			0.2	
Caloneis amphisbaena		0.3		
C. bacillum				0.3
Cocconeis diminuta		0.5	1.1	P
C. disculus				
C. placentula	5.2	0.8	0.2	3.8
C. pediculus			0.7	P
Cyclotella comensis	0.7	1.8	0.7	0.8
C. kutzingiana		0.3	0.2	
C. meneghiniana	1.5	2.6	0.2	2.4
C. ocellata	1.0	1.8	1.4	2.2
C. pseudostelligera			0.5	1.4
Cymatopleura solea		P		P

Table 2. Continued.

SPECIES	STATION			
	27	28	29	30
Cymbella affinis	20.1	7.6	24.6	12.5
C. caespitosa	1.0	P	0.9	0.8
C. cistula			0.2	
C. delicatula				
C. descripta				
C. mexicana				
C. microcephala	7.4	1.3	0.5	
C. minuta	1.0	0.8	0.5	P
C. prostrata	P		P	
C. reichardtii		0.3		
C. sinuata	1.7	2.4	P	0.5
C. sp.				
Denticula elegans				
D. sp.				
Diatoma tenue		0.3		0.3
D. vulgare	0.7	0.3	P	1.1
Diploneis sp.				
Epithemia adnata	0.5			
E. sorex	7.7	3.9	1.6	0.5
E. turgida				
Fragilaria capucina	3.5	1.6	2.0	1.9
F. construens	1.7	11.3	9.7	3.8
F. crotonensis		0.5	6.3	0.3
F. leptostauron	1.0	3.7	0.7	0.5
Frustulia rhomboides		0.3		
Gomphoneis herculeana	P	0.5		
G. eriense		0.5		
G. septa	P			
G. sp.				
Gomphonema angustatum	P	0.3		
G. eroemse				
G. minutum	P		1.1	1.4
G. olivaceum		1.3	0.2	P
G. parvulum	0.2		0.7	

Table 2. Continued.

SPECIES	STATION			
	27	28	29	30
Gomphonema pseudoaugur		P		
G. tergestinum				
G. truncatum				
G. sp.				0.5
Hannaea arcus				
Melosira granulata			2.9	1.9
M. varians			0.9	0.5
M. sp.				0.5
Meridion circulare				
Navicula arvensis				
N. atomus			0.2	
N. aurora				
N. bryophila				
N. capitata v. luneburgensis				P
N. capitatoradiata	3.2	5.2	0.2	2.4
N. cocconeiformis				0.3
N. clementis				
N. cryptocephala				
N. cryptotenella	2.7	2.1	0.9	1.9
N. decussis				
N. difficillima		0.3	0.2	
N. elginensis				
N. exigua		0.3		
N. fracta		0.3		
N. gallica		P		
N. gregaria				
N. libonensis				
N. lanceolata		0.3		
N. menisculus		0.3		P
N. minima	0.2	0.8	0.2	0.5
N. mutica				
N. pelliculosa				
N. phyllepta				P
N. pseudoscutiformis	0.2	0.3		
N. pupula				

Table 2. Continued.

SPECIES	STATION			
	27	28	29	30
Navicula radiosa				
N. scoenfeldii				
N. subhamulata				
N. subminuscula		0.3		
N. subrotundata				
N. (tenelloides ?)				
N. tripunctata	1.7	0.3	0.2	0.3
N. trivialis				
N. tuscula				
N. veneta	0.5	1.3	1.1	0.5
N. viridula				
N. sp.		0.3		
Neidium bisulcatum				
Nitzschia acuta				
N. acidoclinata				
N. acicularis		0.3	0.2	
N. amphibia				
N. delognei				
N. dissipata	1.5	5.0	2.5	6.5
N. frustulum	1.5	3.4	1.4	1.4
N. gandersheimiensis				0.3
N. gracilis		P	0.2	1.9
N. intermedia		0.3		
N. linearis		P		
N. palea	0.2	0.3	1.8	0.8
N. paleacea	1.2	3.7	2.5	3.8
N. romana	0.7	0.5	2.3	7.3
N. sinuata	P	0.3	0.7	
N. sp. #1				
N. sp. #2				
N. sp.		0.3	0.5	0.8
Pinnularia obscura				
Rhopalodia gibba		0.3		
R. gibberula				
Rhoicosphenia curvata	P	0.3		P
Stauroneis smithii		0.3		

Table 2. Continued.

SPECIES	STATION			
	27	28	29	30
Stephanodiscus astraea				P
S. subtilis		0.5	0.7	0.8
S. sp.				
Surirella angustata				
S. ovata		0.3		
Synedra filiformis		0.3	0.2	1.6
S. mazamaensis	0.2	0.3	0.2	2.7
S. ulna	17.9	5.5	0.5	P
Tabellaria sp.	P	0.3		
Unknown				
Total Species	45	67	53	56
Species Counted	36	61	50	44
Frustules Counted	403	382	443	368
Species Diversity (Shannon)	3.980	4.691	4.209	4.664

P means present in the sample but not encountered during the proportional count.

Table 3. Percent relative abundance of diatoms in the three pollution tolerance groups of Lange-Bertalot (1979). Group 1 diatom species are "most tolerant" of pollution; Group 2 diatom species are "less tolerant", and Group 3 species are "sensitive".

STATION		Group 1	Group 2	Group 3
01	(Silver Bow Creek)	58.3	6.7	35.6
02	(Silver Bow Creek)	53.4	4.3	42.5
03	(Silver Bow Creek)	72.7	2.9	24.6
04	(Pond 2 Discharge)	31.2	56.8	12.1
05	(Mill-Willow Bypass)	20.7	61.3	18.3
06	(Warm Springs Creek)	5.4	35.2	59.0
07		28.0	55.1	17.3
08		22.7	38.5	38.4
09		12.9	27.0	60.4
10		22.4	47.8	30.2
11		4.9	33.3	62.0
12		3.2	7.7	88.8
13		1.4	4.5	94.2
14	(Blackfoot River)	7.6	21.4	70.8
15		1.9	19.1	78.7
16		3.6	18.6	78.4
17	(Missoula WWTP)			
18		1.6	18.8	79.7
19	(Bitterroot River)	4.5	28.4	67.0
20		2.2	3.1	94.5
21	(Stone Container)			
22		5.0	12.2	83.4
23		7.7	7.7	83.9
24		3.1	13.1	83.6
25		2.8	19.6	78.4
26	(Flathead River)	5.1	25.5	69.9
27		19.0	22.2	58.3
28		8.2	25.3	67.6
29		4.5	22.5	73.0
30		2.1	26.3	71.3

Reference: Lange-Bertalot, Horst. 1979. Pollution tolerance of diatoms as a criterion for water quality estimation. Nova Hedwigia 64:285-304.